

DEPARTMENT OF COMMERCE

Chapter Comm 23**HEATING, VENTILATING AND AIR CONDITIONING STANDARDS**

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Note: Chapter Ind 23 was renumbered to be chapter ILHR 23, Register, February, 1985, No. 350, eff. 3-1-85. Chapter ILHR 23 was renumbered Chapter Comm 23 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 7., Stats., Register, January, 1999, No. 517.

Subchapter I — Scope**Comm 23.01 Scope.**

The provisions of this chapter shall apply to the design, installation and construction of all heating, ventilating and air conditioning systems in dwellings covered by this code.

Subchapter II — Design**Comm 23.02 Design.**

Every dwelling shall be equipped with a heating system designed in accordance with this section. Heating equipment requirements may be waived for recreational dwellings used only during the non-heating season. Where a cooling system is provided, the cooling requirements of this section shall be met.

Recreational or Small Dwellings

Question: Does a house need a heating system?

Answer: *No. It would then be considered a recreational or seasonal dwelling as defined in s. Comm 20.04(1). Compliance with Ch. 22, Energy Conservation, would not be required if there is no heating system. However, an owner would be required to retrofit the house to meet Ch. 22 standards before it could be heated and used for year-round use in the future. Some foresight by the builder/owner would be necessary if they contemplate it may be used year-round in the future*

(1) HEATING AND COOLING SYSTEM DESIGN. (a) Indoor and outdoor design temperatures shall be selected from s. Comm 22.07.

(b) The heating and cooling systems shall be designed to maintain the indoor design temperature at outdoor design conditions.

(c) When requested, room-by-room heat loss and heat gain calculations shall be furnished.

(2) DISTRIBUTION SYSTEMS. Distribution systems shall be sized and located to satisfy the heating and cooling loads of each conditioned space. When requested, a layout of the distribution system shall be furnished to show that the system meets the requirements of this code.

(3) VENTILATION. (a) General. All exhaust vents shall terminate outside the structure.

1. Mechanical ventilation systems shall be balanced.

Question: *What does "balanced" mean in this section?*

Answer: *It means that the ventilation system should not produce excessive positive or negative pressures in the dwelling.*

2. Infiltration may not be considered as make-up air for balancing purposes.

3. All exhaust vents shall terminate outside the structure.

Exhaust Fan Termination

Question: *Can an exhaust fan terminate inside a garage, crawlspace or attic near a vent?*

Answer: *No. It must have an exterior termination. The air currents may otherwise draw the exhaust back into the space.*

4. Intake air ducts shall be sized to provide a maximum of 40% of the total air that would be exhausted with all exhaust ventilation in the dwelling acting simultaneously.

Question: *What calculation method can be used to determine the make-up air needed for exhaust fans?*

Answer: The minimum amount of make-up air must be 40% of the total exhaust. Size the duct considering the maximum flowrate conditions specified in s. Comm 23.07. Comm 23.07 - TABLE (DUCT VELOCITIES) Per this table, the minimum duct velocity is 500 ft/min and maximum allowable is 800 ft/min.

Example: Determine size of make-up air duct required for these exhaust systems.

Range hood	=	180 cfm (intermittent)	x	40%	=	72 cfm
Bath exhaust 1	=	50 cfm (intermittent)	x	40%	=	20 cfm
Bath exhaust 2	=	75 cfm (intermittent)	x	40%	=	30 cfm
TOTAL		305 cfm (intermittent)	x	40%	=	122 cfm

Based on the formula of Quantity = Velocity times Area ($Q=VA$). THEREFORE:...

$A=Q/V$, or $A=122/800$, or $A=.1525$ sq. ft. x 144 = 21.96 sq. in. (Required)

Try 4" Round duct = $3.14 \times \text{radius squared} = 3.14 \times 2 \times 2 = 12.56$ sq. in. (Too small)

Try 6" Round duct = $3.14 \times \text{radius squared} = 3.14 \times 3 \times 3 = 28.26$ sq. in. (OK, since > 21.96)

Not doing the calculation described above to appropriately size the air intake may result in an oversize intake and cause the problems noted above. Note: System should be tested per 23.18 to make sure the design amounts of air are actually provided when the system operates.

5. Kitchen range hoods that exhaust air from the kitchen area shall terminate outside the structure and shall be considered as exhaust ventilation for balancing and makeup purposes.

6. Kitchen range hoods that are listed and installed to recirculate air without exhausting it are not required to be balanced.

(b) 1. 'General.' Except as provided under subd. 2., mechanical ventilation systems shall be balanced.

2. 'Exception.' Passive intake air ducts providing makeup air for intermittent exhaust fans shall be sized to provide at least 40 percent of the total air that would be exhausted with all intermittent exhaust ventilation in the dwelling operating simultaneously.

3. 'Kitchen range hoods.' a. Kitchen range hoods that exhaust air from the kitchen area are considered as exhaust ventilation for balancing and makeup purposes.

b. Kitchen range hoods that are listed and installed to recirculate air without exhausting it are not required to be balanced.

4. 'Infiltration.' a. Infiltration may be considered as makeup air for balancing purposes only where there are no naturally vented space- or water-heating appliances in the dwelling.

b. For the purpose of complying with this subdivision, naturally vented space- or water-heating appliances are those that take combustion of dilution air from inside the dwelling, including unsealed fireplaces and draft hood appliances with power venting.

Note: Whole-house fans that are used in the summer to bring cool night air in through open windows and exhaust into the attic are considered to be a supplemental cooling system rather than part of the ventilation system.

Note: See s. Comm 22.14 for additional requirements on mechanical ventilation.

(c) Habitable rooms. Habitable rooms without openable windows shall be provided with a balanced mechanical ventilation system producing one air change per hour of fresh outside air while the room is occupied.

(d) Rooms with toilets, tubs or showers. Any room with a toilet, tub or shower shall be provided with exhaust ventilation capable of exhausting 50 cubic feet per minute on an intermittent basis or 20 cubic feet per minute on a continuous basis.

Note: The department will accept designs which meet the Air Conditioning Contractors of America manual; the Mechanical Contractors Association manual; and the Sheet Metal and Air Conditioning Contractors National Association standards for heating and air conditioning systems for one- and 2-family dwellings.

Ductless Recirculating Fans

Question: *Are there any department-approved ductless recirculating bathroom fans that may be used in lieu of natural ventilation or mechanical ventilation?*

Answer: *No. In rooms with a toilet, tub, or shower, it is required by (3)(d) that mechanical exhaust fans, ducted to outside the dwelling, be installed even where openable windows are present.*

(4) CONTROLS. The temperature rise through the equipment shall not exceed 100° F unless listed. Controls shall be provided to maintain the inside temperature. Where forced, warm-air systems are used, controls shall be installed to control air movement.

Subchapter III — Heating Equipment

Comm 23.03 Selection of equipment.

All heating and central cooling equipment shall be selected on the basis of air-handling capacity, pumping capacity, and thermal capacity to handle the calculated design heating or cooling load.

Selection of Equipment

Question: *The UDC Energy Worksheet or Wischeck is used to determine both the maximum and minimum heating system output. Can this minimum be reduced?*
Answer: *Yes, if proper calculations are submitted showing any solar gain, internal gain from appliances or other sources.*

Comm 23.04 Types and location of equipment.

All heat producing appliances and cooling appliances shall be listed by a testing agency acceptable to the department. The clearances from combustible materials in Tables 23.04-A and 23.04-B shall apply unless otherwise shown on listed appliances.

Types of Equipment

All heating equipment including woodstoves and decorative gas appliances (gas fireplaces) must be listed by a recognized testing agency. An important part of inspecting an appliance's installation is to check against its listed installation requirements. Therefore, it is good practice to refer to the installation manual when installing and inspecting the installation. Per s. Comm 23.18(1), an appliance's manual is required to be left with the owner. Per s. Comm 20.09, it can be required for plan review or inspection by the inspector.

Table 23.04-A
STANDARD INSTALLATION CLEARANCES (INCHES) FOR HEAT-PRODUCING APPLIANCES

Residential Type Appliances for Installation in Rooms Which are Large See Note 2		Appliances ¹				
		Above Top of Casing or Appliance	From Top and Sides of Warm- Air Bonnet or Plenum	From Front See Note 3	From Back	From Sides
Boilers and Water Heaters						
Automatic Oil						
Steam Boilers - 15 psi	or	6	---	24	6	6
Water Boilers - 250°F	Comb. Gas-Oil					
Water Heaters - 200°F	Automatic Gas	6	18	6	6	
All Water Walls or Jacketed	Electric	6	---	18	6	6
Furnaces - Central						
Gravity, Upflow, Downflow, Horizontal and Duct, Warm-Air - 250°F	Automatic Oil	6 ⁴	6 ⁴	24	6	6
	or					
	Comb. Gas-Oil	6 ⁴	6 ⁴	18	6	6
	Automatic Gas	6 ⁴	6 ⁴	18	6	6
	Electric	6 ⁴	6 ⁴	18	6	6
Furnaces - Floor						
For Mounting in Combustible Floors	Automatic Oil	36	---	12	12	12
	or					
	Comb. Gas-Oil	36	---	12	12	12
	Automatic Gas	36	---	12	12	12
	Electric	36	---	12	12	12
Heat Exchanger						
Steam - 15 psi Max.						
Hot Water - 250°F Max.	---	1	1	1	1	1
Room Heaters						
Circulating Type	Oil	36	---	24	12	12
Vented or Unvented	Gas	36	---	24	12	12
	Oil	36	---	36	36	36
Radiant or Other Type	Gas	36	---	36	18	18
Vented or Unvented	Gas with dbl Metal or Ceramic back	36	---	36	12	18
Radiators						
Steam or Hot Water	Gas	36	---	6	6	6

Table 23.04-A (Continued)

Residential Type Appliances for Installation in Rooms Which are Large See Note 2		Appliances ¹					
		Above Top of Casing or Appliance See Note 5	From Top and Sides of Warm- Air Bonnet or Plenum	From Front See Note 3	From Back	From Sides	
						Firing Side	Opp. Side
Ranges - Cooking Stoves Vented or Unvented	Oil	30	---	---	9	24	18
	Gas	30	---	---	6	6	6
	Electric	30	---	---	6		6
Clothes Dryers Listed Types	Gas	6	---	24	6		6
	Electric	6	---	24	0		0
Incinerators		See Note 6					
Residential Types	---	36	---	48	36		36

¹ Standard clearances may be reduced by affording protection to combustible material in accordance with Table 23.04-B.

² Rooms which are large in comparison to the size of the appliance are those having a volume equal to at least 12 times the total volume of a furnace and at least 16 times the total volume of a boiler. If the actual ceiling height of a room is greater than 8 feet, the volume of a room should be figures on the basis of a ceiling height of 8 feet.

³ The minimum dimension should be that necessary for servicing the appliance including access for cleaning and normal care, tube removal, etc.

⁴ For a listed oil, combination gas-oil, gas, or electric furnace, this dimension may be 2 inches if the furnace limit control cannot be set higher than 250°F or this dimension may be one inch if the limit control cannot be set higher than 200°F.

⁵ To combustible material or metal cabinets. If the underside of such combustible material or metal cabinet is protected with asbestos millboard at least 1/4 inch thick covered with sheet metal of not less than No. 28 gauge, the distance may be not less than 24 inches.

⁶ Clearance above charging door should be not less than 48 inches.

Table 23.04-B
CLEARANCES, INCHES, WITH SPECIFIED FORMS OF PROTECTION*

Type of Protection Applied to the combustible material unless otherwise specified and covering all surfaces within the distance specified as the required clearance with no protection. Thicknesses are minimum.	Where required clearances with no protection is:											
	36 Inches			18 Inches			12 Inches			6 Inches		
	Above	Sides and Rear	Vent Con- nector	Above	Sides and Rear	Vent Con- nector	Above	Sides and Rear	Vent Con- nector	Above	Sides and Rear	Vent Con- nector
(a) 1/4" insulating millboard** spaced out 1"***	30	18	20	15	9	12	9	6	6	3	2	3
(b) 28 gauge sheet metal on 1/4" insulation millboard**	24	18	24	12	9	12	9	6	4	3	2	2
(c) 28 gauge sheet metal spaced out 1"***	18	12	18	9	6	9	6	4	4	2	2	2
(d) 28 gauge sheet metal on 1/4" insulation millboard** spaced out 1"***	18	12	18	9	6	9	6	4	4	2	2	2
(e) 1/4" insulated millboard** on 1" mineral wool batts reinforced with wire mesh or equivalent.	18	12	18	6	6	6	4	4	4	2	2	2
(f) 22 gauge sheet metal on 1" mineral wool batts reinforced with wire or equivalent.	18	12	12	4	3	3	2	2	2	2	2	2
(g) 1/4" insulated millboard***	36	36	36	18	18	18	12	12	9	4	4	4

* All clearances shall be measured from the outer surface of the equipment to the combustible material disregarding any intervening protection applied to the combustible material.

** A factory fabricated board formed with noncombustible materials, normally fibers, and having a thermal conductivity in the range of 1 Btu inch per square foot per °F, or less.

*** Spaces shall be of noncombustible material.

(1) FURNACES. The input and output capacity of furnaces shall be listed on the nameplate. All nameplates shall show evidence that the equipment has been listed by a recognized testing laboratory.

(a) Fuel supply. Furnaces shall be fired with the fuel for which they have been approved, except as provided in par. (d). Fuels shall be supplied to the furnace in the volume and at the pressure required on the label.

(b) Unvented furnaces and space heaters. The use of unvented furnaces and space heaters fueled by natural gas, kerosene, alcohol or other fuel shall be prohibited due to concerns about oxygen depletion; contamination from carbon monoxide, carbon dioxide, nitrogen dioxide, formaldehyde and other combustion related contaminants; and water vapor buildups.

(c) Vented wall furnaces. Vented wall furnaces shall not be equipped with duct extensions beyond the vertical and horizontal limits of the enclosure unless listed. Vented wall furnaces shall be located to prevent the restriction of air circulation by doors, projections, or other openings. Vented wall furnaces shall be provided with combustion air.

Unvented Furnaces and Space Heaters and Fireplaces

Portable kerosene and other types of unvented heaters are being advertised and sold in Wisconsin. However, neither the Commercial Building Code nor the Uniform Dwelling Code permit their use. Use of such heaters is prohibited because the heaters are not vented and can cause a buildup of carbon monoxide and moisture in the room. Further, the heaters require frequent refueling which can lead to spillage and additional fire hazard.

A carbon monoxide problem can develop where improper fuels are used or inadequate ventilation is provided. To comply with the terms of their listings, most units being advertised must utilize the type "I-K" odorless kerosene to enable them to burn at low carbon monoxide levels. Unfortunately, this type of kerosene is available in Wisconsin only on a very limited basis, usually to commercial customers. Use of other kerosene makes the listing meaningless. In homes not covered by the Uniform Dwelling Code, homeowners should be made aware that, where heaters are used, special care should be taken to ensure the proper fuels and ventilation are provided.

Question: *If unvented heaters are prohibited by the UDC and the Commercial Building Code, why are kerosene heaters still being sold?*

Answer: *These heaters are not necessarily illegal in structures not covered by either code, such as pre-1980 dwellings or agricultural buildings. However, some municipalities have adopted ordinances prohibiting unvented heaters in pre-1980 dwellings or other buildings.*

Question: *Can an unvented heater be used in a residential garage?*
Answer: *Only in detached garages since the UDC Comm 20.07 (35) defines an attached garage as part of the dwelling. Therefore, the garage would have to comply with all chapters of the UDC. Most municipalities have their own ordinances of codes covering construction of accessory buildings.*

(d) Conversion burners. Conversion burners shall be listed by a recognized testing laboratory. The existing equipment shall be reconditioned and defective parts replaced before a conversion burner is installed. Conversion burners shall be installed in accordance with the installation instructions.

(2) HEAT PUMP APPLIANCES. (a) Size. Heat pump appliances shall be sized to provide control of the wet and dry bulb temperatures during cooling and maximum performance during heating. The heating balance point shall be considered to determine the outdoor temperature at which the heat pump must operate 100% of the time to offset the dwelling heat loss.

(b) Auxiliary heaters. Provisions for auxiliary heat to supplement the heat pump at outdoor temperatures below the balance point shall be provided. Auxiliary heaters shall be sized so that the heat pump auxiliary will offset the dwelling heat loss down to the heating design temperature.

(3) BOILERS. Boilers shall comply with ch. COMM 41-42, Boiler and Pressure Vessel Code, ss. COMM 41.10 and 41.42 through 41.45.

Note: The department will accept equipment listed by the American Society of Mechanical Engineers, Underwriters' Laboratories, and the American Gas Association.

See informational flyer at the back of this chapter regarding water heaters used for space heating purposes.

(4) LOCATION. (a) Enclosed spaces. Except as provided in par. (c), no space-heating or water-heating appliance shall be installed in a bedroom, bathroom, closet, or garage unless listed for such installation.

(b) Garages. Appliances installed in garages shall have burners and burner ignition devices located at least 18 inches above the floor and shall be protected or located so the furnace is not subject to damage from a vehicle.

(c) Exceptions. 1. Vented decorative gas appliances and decorative gas appliances for installation in vented fireplaces may be installed in bedrooms or bathrooms only when both of the following conditions are met:

a. The volume of the space in which the appliance is located is not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel-burning appliances installed in that space.

The space may be made up of more than one room if the rooms are connected through doorway openings without doors.

b. The vapor retarder is not continuous on walls and ceilings exposed to the outside atmosphere as allowed under s. Comm 22.22.

2. Water heaters may be installed in a closet located in a bathroom or bedroom where the closet is used exclusively for the water heater, where the enclosed space has a weather-stripped solid door with a self-closing device, and where all air for combustion is obtained from the outdoors.

Note: Section Comm 23.06 still requires combustion air to be provided to the appliance.

Location

Question: *How do I determine if a furnace is listed for installation in a bedroom, bathroom, closet or garage?*

Answer: *Although this information may not be shown on the unit, it does need to be covered in the installation instructions which must be provided to the owner, per s. Comm 23.18. Many times these installation instructions reference NFPA-54, National Fuel Gas Code for garage installation procedures.*

Question: *Since this section limits location of furnaces in a garage, can a wood stove or other space heater be located in a garage?*

Answer: *Not unless listed for such use. See s. Comm 23.045(2)(c).*

Question: *Can a furnace be located in an attic?*

Answer: *Yes, if within the manufacturer's listing requirements. The following UDC requirements and typical manufacturer's requirements would usually apply:*

- *Provide attic access opening large enough for the appliance.*
- *Provide combustion air per s. Comm 23.06.*
- *Maintain manufacturer's and UDC clearances to combustibles and clearances for servicing.*
- *Provide lighting for servicing the appliance.*
- *Provide a solid walkway to the appliance and solid platform under and around the appliance for servicing.*
- *The attic framing must be designed to support the furnace and servicing loads.*
- *Isolate the appliance from any loose insulation that could enter the combustion chamber.*
- *Isolate the appliance from any drafts caused by power attic venting of the attic.*

Also, the furnace must be able to withstand freezing temperatures which may adversely affect condensing-type furnaces.

Comm 23.045 Solid-fuel-burning appliances.

(1) GENERAL. Solid-fuel- burning appliances shall be installed as specified in this section unless the manufacturer or listing specifies the use of protection or clearances other than those specified in this section. All solid-fuel-burning appliances shall be tested and listed by an accepted testing agency.

Note: Factory-built fireplaces shall comply with s. Comm 21.32.

Solid-Fuel-Burning Appliances

Effective February 1, 1989, solid-fuel-burning appliances had to be tested, listed and labeled by an accepted testing agency. (See s. Comm 21.32 commentary for approved agencies.)

At the time the Dwelling Code was first written (1980), nationally recognized standards on solid-fuel-type appliances were not available. Since that time, Underwriters' Laboratories have developed standards for testing and listing solid-fuel- burning appliances. Most models on the market are now tested, listed and labeled by approved independent agencies.

Appliance Testing and Listing

When a specific installation instruction approved by the testing/listing agency is more or less stringent than s. Comm 23.045, then the listing agencies instructions govern.

(2) LOCATION OF APPLIANCES. (a) Servicing. Every appliance shall be located to permit access to the appliance. Sufficient clearance shall be maintained around the equipment to permit cleaning of surfaces; the replacement of air filters, blowers, motors, controls and chimney connectors; the lubrication and servicing of moving parts; and the adjustment and servicing of stokers and appliance components.

(b) Garages. Solid-fuel-burning appliances may not be installed in a garage.

(3) CHIMNEYS. (a) Solid-fuel-burning appliances shall be connected to one of the following types of chimneys:

1. Factory-built chimneys or vents. A listed residential-type and building heating appliance chimney may be used with solid-fuel-burning appliances if the chimneys have been tested 3 times to a minimum flue gas temperature exposure of 2100° F, under the conditions specified by the listing agency, for at least 10 minutes each time.

Note: Products listed and labeled as complying with UL 103 – "Type HT" meet this requirement. UL 103 uses several temperature ranges for different products but only the "Type HT"-designated products have met the 2100°F testing requirement.

2. Masonry chimneys. Masonry chimneys shall be constructed as specified in s. Comm 21.30.

(b) Wood-burning equipment shall not be connected to a flue serving a fireplace or other equipment.

Co-venting of Solid-Fuel Appliances

Note that this section does not allow co-venting of solid-fuel appliances. Each fireplace, woodstove, or other solid-fuel appliance must be vented to its own flue.

(c) The chimney shall be designed to create a natural draft to carry away the products of combustion or provision shall be made for mechanically maintaining constant updraft during equipment operation.

(d) A cleanout opening shall be provided.

(e) A listed, multifuel appliance may be vented into a single flue.

(4) CHIMNEY CONNECTORS. (a) All solid-fuel-burning appliances shall be connected to chimneys with factory-built chimney material, Type L vent material or steel pipe with minimum thicknesses as specified in Table 23.045-A.

TABLE 23.045-A

METAL THICKNESS FOR PIPE CONNECTORS

Diameter of Connector (inches)	Sheet Gage No.	Minimum Thickness (inches)
6 to 10	24	.023
over 10 to 16	22	.029
over 16	16	.056

(b) The required clearance to combustibles for chimney connectors shall be 18 inches. This clearance may be reduced in accordance with Table 23.045-B. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045-A.

(c) Connectors and chimneys for solid-fuel-burning appliances shall be designed, located and installed to permit ready access for internal inspection and cleaning.

(d) 1. Chimney connectors shall have no more than two 90° elbows.

2. The horizontal length shall not exceed 75% of the total vertical height of the entire venting system measured from the appliance outlet.

3. The connector shall maintain a rise of at least 1/4 inch per foot from the appliance outlet to the chimney inlet.

4. Connectors shall be securely supported and joints fastened with a minimum of 3 sheet metal screws or rivets.

5. Appliances used mainly for wood burning shall have the joints assembled so that the crimped end points towards the stove. Appliances burning coal shall have the joints assembled so that the crimped end points away from the appliance.

6. A connector to a masonry chimney shall extend through the wall to the innerface of the liner but not beyond.

7. The effective area of the connector shall not be less than the area of the appliance flue collar.

(e) No chimney connectors may pass through any floor, ceiling, window, door or combustible wall nor be concealed in any closet, attic or similar space. A connector may pass through a combustible wall if the connector is guarded at the point of passage by one of the following methods:

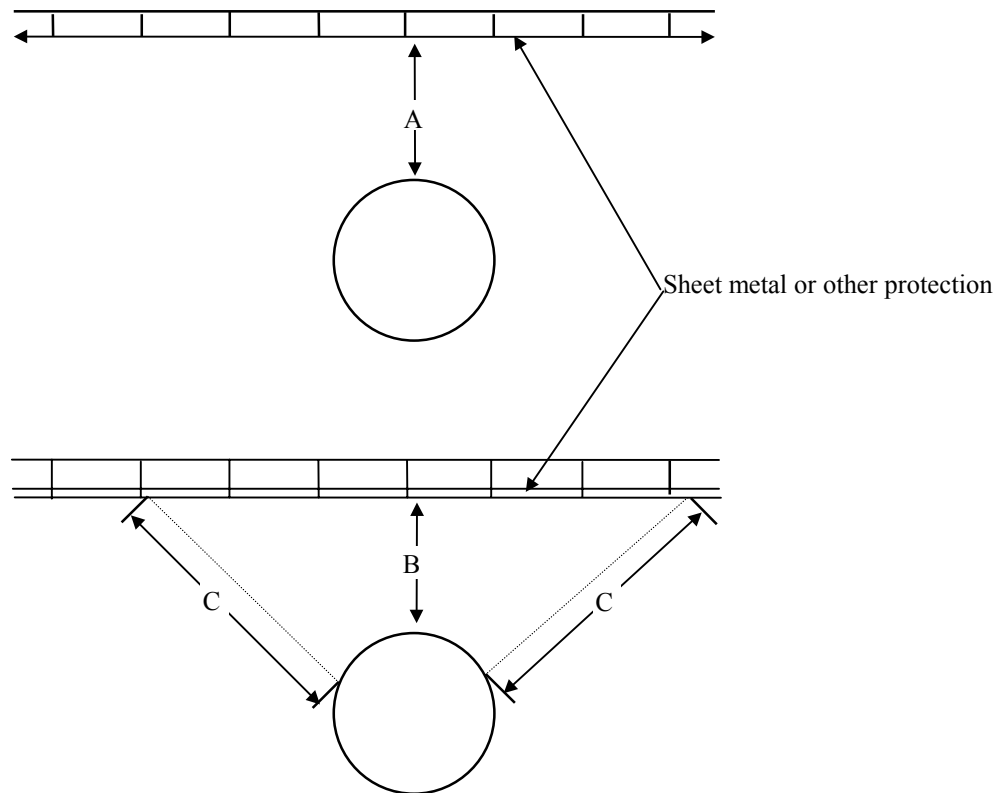
1. Metal ventilated thimble not less than 12 inches larger in diameter than the connector.

2. All combustible material in the wall is cut away from the connector a sufficient distance to provide the required 18-inch clearance. Any material used to close up such openings shall be noncombustible.

(f) A manual, cast iron damper to control draft shall be provided in the chimney connector. The damper shall not obstruct more than 80% of the connector area. Listed solid-fuel appliances whose listing prohibits the use of manual dampers in the connector shall not require a manual damper to be installed.

FIGURE 23.045-A

CONSTRUCTION USING COMBUSTIBLE MATERIAL



"A" Equals the required clearance with no protection, specified in s. Comm 23.045 (4) (b).

"B" Equals the reduced clearance permitted in accordance with Table 23.045-B. The wall protection should extend far enough in each direction to make "C" equal to "A".

TABLE 23.045-B

Type of Protection	Minimum Required Connector Clearances (inches)
0.013-in. (28 gage) sheet metal spaced out a minimum of one inch.	9
3 1/2-in. thick masonry wall spaced out a minimum of one inch and adequately tied to the wall being protected (see Note 4).	9
0.027-in. (22 gage) sheet metal on one-inch mineral wool batts reinforced with wire or equivalent spaced out a minimum of one inch.	3

¹ Spacers and ties shall be of noncombustible material.

² All methods of protection require adequate ventilation between protective material and adjacent combustible walls and ceilings.

³ Mineral wool batts (blanket or board) shall have a minimum density of 8 pounds per cubic foot and a minimum melting point of 1550° F.

⁴ If a single wall connector passes through the masonry wall, there shall be at least 1/2 inch of open ventilated air space between the connector and the masonry.

Chimney Connectors

Question: Does a solid fuel appliance in front of an existing fireplace opening require a chimney connector?

Answer: Usually, for proper operation, a smokepipe is needed from the appliance outlet to the opening of the actual chimney flue per its listing. Additionally, a factory-built fireplace's listing must be compatible for such an alteration.

(5) MOUNTING ON FLOORS. (a) Appliances shall be placed on surfaces as described in Table 23.045-C. Solid-fuel-burning appliances listed specifically for installation on a floor constructed of combustible material may be installed in accordance with the terms of the listing and the manufacturer's instructions.

TABLE 23.045-C

FLOOR MOUNTINGS FOR SOLID-FUEL-BURNING APPLIANCES

Kind of Appliance	Allowed Mounting
(1) All forced air and gravity furnaces, steam and water boilers. or	Floors of fire-resistive construction with noncombustible flooring and surface finish, or fire-resistive arches or slabs. This construction may not have combustible material against the underside. Such construction shall extend at least 18 inches beyond the appliance on all sides.
(2) Residential-type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters, having less than 2 inches of ventilated open space beneath the fire chamber or base of the appliance.	These appliances shall not be placed on combustible floors.
(3) Residential-type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing 2 to 6 inches of ventilated open space beneath the fire chamber or base of the appliance.	On combustible floors when such floors are protected by 4 inches of hollow masonry, laid to provide air circulation through the masonry layer. Such masonry shall be covered with 24 gauge sheet metal. The required floor protection shall extend at least 18 inches on all sides of the appliance.
(4) Residential-type ranges, water heaters, fireplace stoves, room heaters and combination fireplace stove/room heaters having legs or pedestals providing over 6 inches of ventilated open space beneath the fire chamber or base of the covered appliance.	Noncombustible floors shall extend at least 18 inches on all sides of the appliance. On combustible floors when such floors are protected by closely spaced masonry units of brick, concrete or stone, which provide at least 2 inches of thickness. Such masonry shall be covered by or placed over a sheet of 24 gauge sheet metal. The required floor protection shall extend at least 18 inches on all sides of the appliance. Noncombustible floors shall extend at least 18 inches on all sides of the appliance.

(6) CLEARANCES. (a) Solid-fuel-burning appliances shall be installed with clearances not less than specified in Table 23.045-D.

1. Listed appliances exception. Listed appliances shall be installed in accordance with the terms of their listing if greater clearances other than those specified by Table 23.045-D are required in accordance with the listing.

2. Clearance with protection exception. Solid-fuel-burning appliances may be installed with reduced clearances provided the combustible material is protected as described in Table 23.045-E. The specified protection shall be applied to and cover all combustible material as specified in Figure 23.045-B.

TABLE 23.045-D

STANDARD CLEARANCES FOR SOLID-FUEL-BURNING APPLIANCES

Type of Appliance	Above Top of Casing or Appliance. Above Top and Sides of Furnace Plenum or Bonnet (inches)	Minimum Standard Clearances (inches)		
		From Front	From Back	From Sides
<u>Residential Appliances</u>				
Steam Boilers - 15 psi				
Water Boilers - 250° F max.	6	48	6	6
Water Boilers - 200° F max.				
All Water Walled or Jacketed				
<u>Furnaces</u>				
Gravity and Forced Air	18	48	18	18
<u>Room Heaters, Fireplace Stoves, Combinations</u>				
	36	36	36	36
			Firing Opp. Side	Side
<u>Ranges</u>				
Lined Firechamber	30	36	24	18
Unlined Firechamber	30	36	36	18

TABLE 23.045-E

MINIMUM ALLOWABLE APPLIANCE CLEARANCE WITH PROTECTION^{1,2,3,4,5,6}

Type of Protection	Unprotected Clearances (inches) From Table 23.045-D								
	For Ceilings				For Walls				
	6	18	30	36	6	18	24	36	48
3 1/2-in. thick masonry wall without ventilated air space	-	-	-	-	4	12	16	24	32
1/2-in. thick noncombustible insulation board over 1-in. glass fiber or mineral wool batts without ventilated air space	4	12	20	24	3	9	12	18	24
0.024-in. (24 gage) sheet metal over 1-in. glass fiber or mineral wool batts reinforced with wire, or equivalent, or rear face with ventilated air space	3	9	15	18	2	6	8	12	16
3 1/2-in. thick masonry wall with ventilated air space	-	-	-	-	2	6	8	12	16
0.024-in. (24 gage) sheet metal with ventilated air space	3	9	15	18	2	6	8	12	16
1/2-in. thick noncombustible insulation board with ventilated air space	3	9	15	18	2	6	8	12	16
0.024-in. (24 gage) sheet metal with ventilated air space over 0.024-in. (24 gage) sheet metal with ventilated air space	3	9	15	18	2	6	8	12	16
1-in. glass fiber or mineral wool batts sandwiched between two sheets 0.024-in. (24 gage) sheet metal with ventilated air space	3	9	15	18	2	6	8	12	16

¹ Spacers and ties shall be of noncombustible material. No spacers or ties shall be used directly behind appliance or conductor.

² With all clearance reduction systems using a ventilated air space, at least two sides of the protection shall be open to provide adequate air circulation. There shall be at least one inch between the clearance reduction system and combustible walls and ceilings.

³ Mineral wool bats, blanket or board shall have a minimum density of 8 lb. per cubic foot and have a minimum melting point of 1,500°F.

⁴ Insulation material used as part of a clearance reduction system shall have a thermal conductivity (k) of One (Btu) (in)/(Sq. ft.) (Hr.) (°F) or less. Insulation board shall be formed of noncombustible material.

⁵ If a single wall connector passes through a masonry wall used as a wall shield, there shall be at least 1/2 inch of open, ventilated space between the connector and the masonry.

⁶ Clearances in front of the loading door or ash removal door of the appliance shall not be reduced.

FIGURE 23.045-B

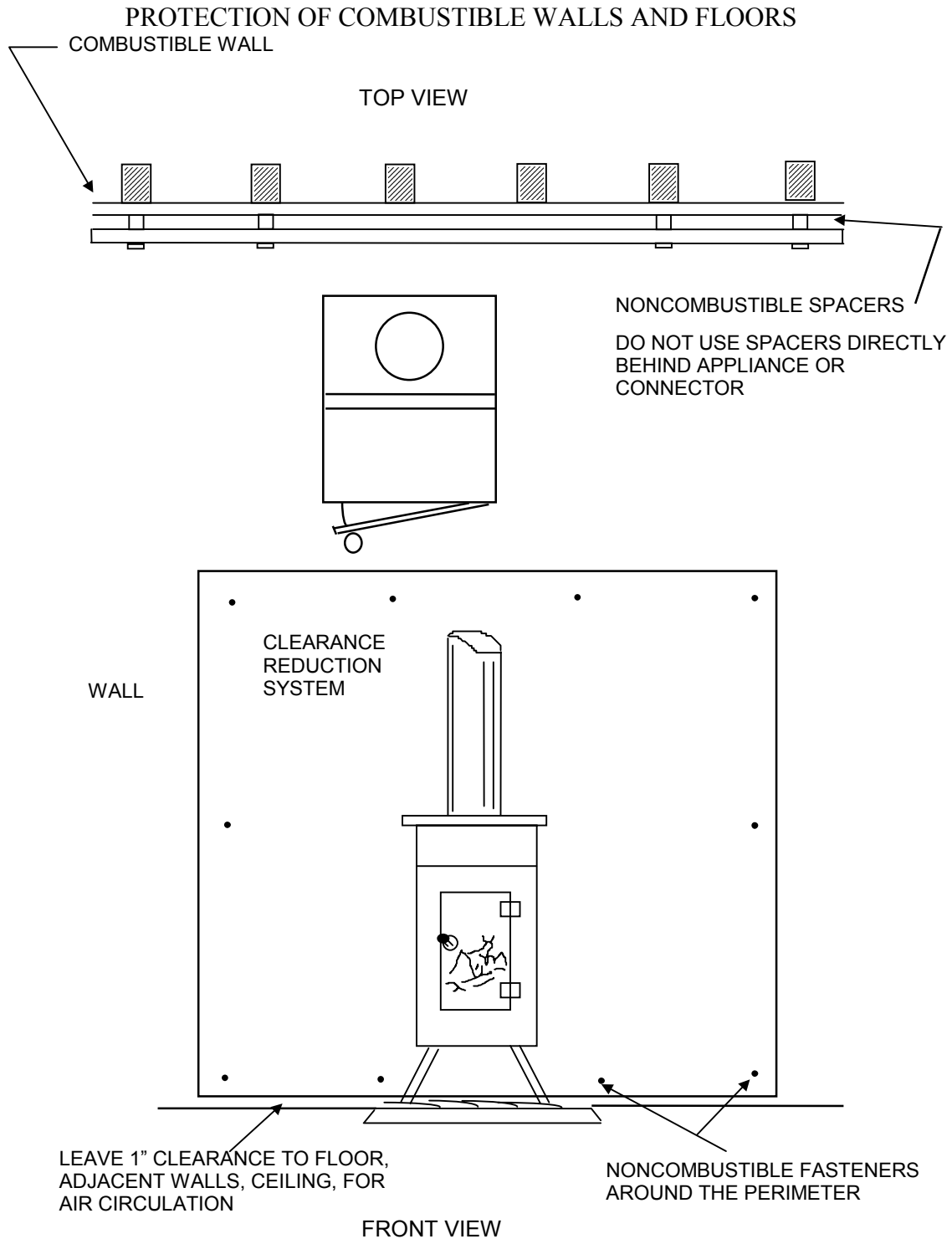
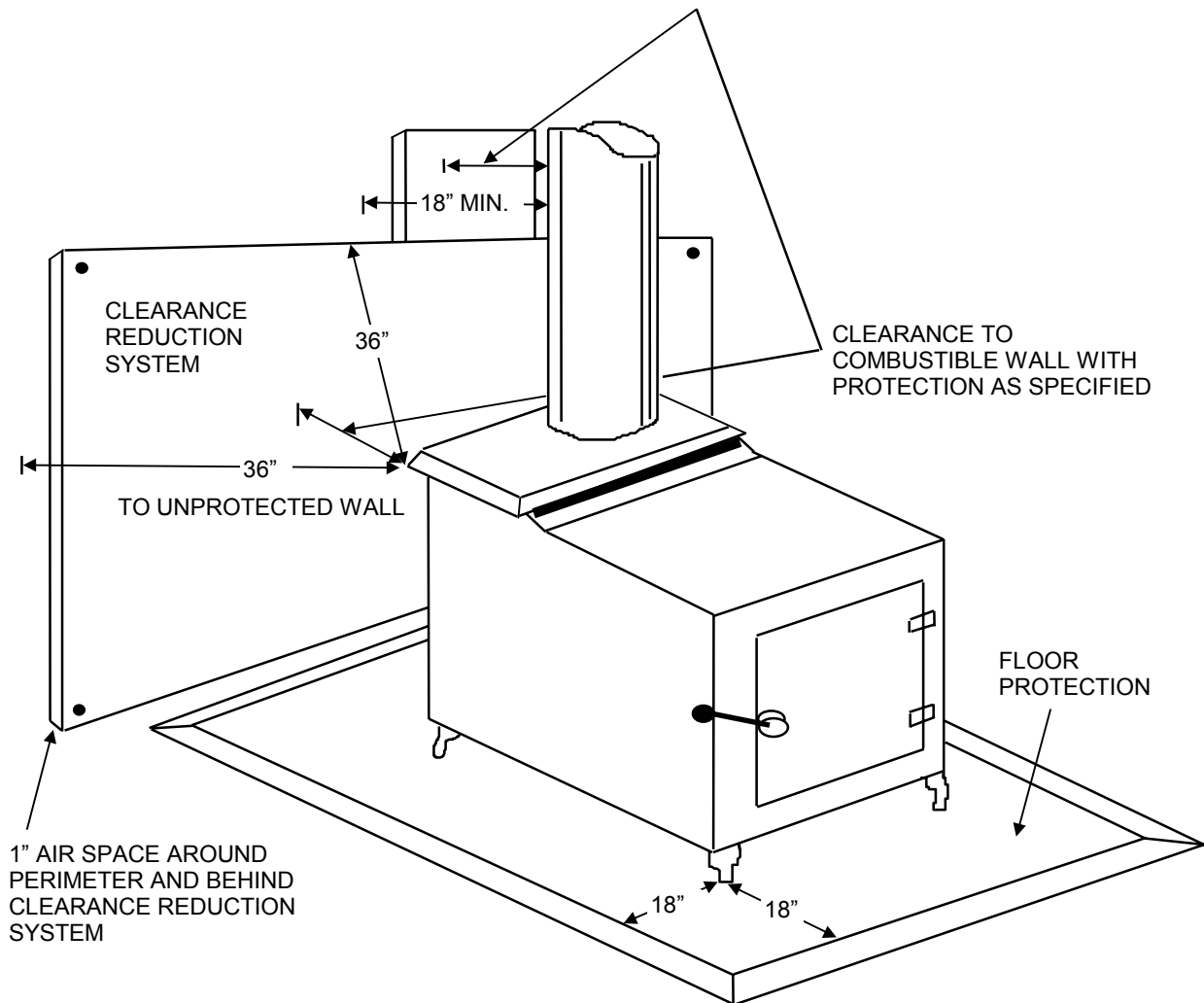


FIGURE 23.045-B (continued)



Clearances

The requirement for proper clearances in this section refers to clearances to combustibles. It should be remembered that an appliance still needs to comply with s. Comm 23.045(2) for the proper servicing clearances.

It is important to keep in mind that a wood-frame wall with drywall or plaster finish is still considered a combustible wall for determining appliance and smokepipe clearances. Heat is readily conducted to the studs underlying the drywall. Over a period of time, the ignition temperature of the wood decreases as it is dried out and chemically changed. Noncombustible surface protection is only effective if there is at least a 1-inch air space between it and the combustible construction.

(7) ACCESSORIES. Accessories for solid-fuel-burning appliances such as heat exchangers, stove mats, floor pad and protection shields, shall be listed and shall be installed in accordance with the terms of their listing.

(8) SUPPLEMENTAL UNITS. Supplemental solid-fuel-burning units connected to a furnace shall be connected to the warm air side of the furnace as illustrated in Figures 23.045-C to E.

(a) Return air duct. The area of the return air duct shall be at least equal to the area of the warm air supply duct. The return air duct shall be of the same material as specified for supply air ducts. Return air grilles shall not be located in bathrooms, kitchens, garages, utility spaces or in a confined space defined under s. Comm 23.06 in which a draft diverter or draft regulator is located.

(b) Blower. The blower on the furnace shall maintain the manufacturer's specifications for cubic feet per minute air flow and static pressure when the supplemental unit is in operation.

(c) Outside air intake. The outside air intake shall be connected to the cold air return plenum of the furnace. A volume damper shall be placed in the duct for the fresh air intake.

FIGURE 23.045-C

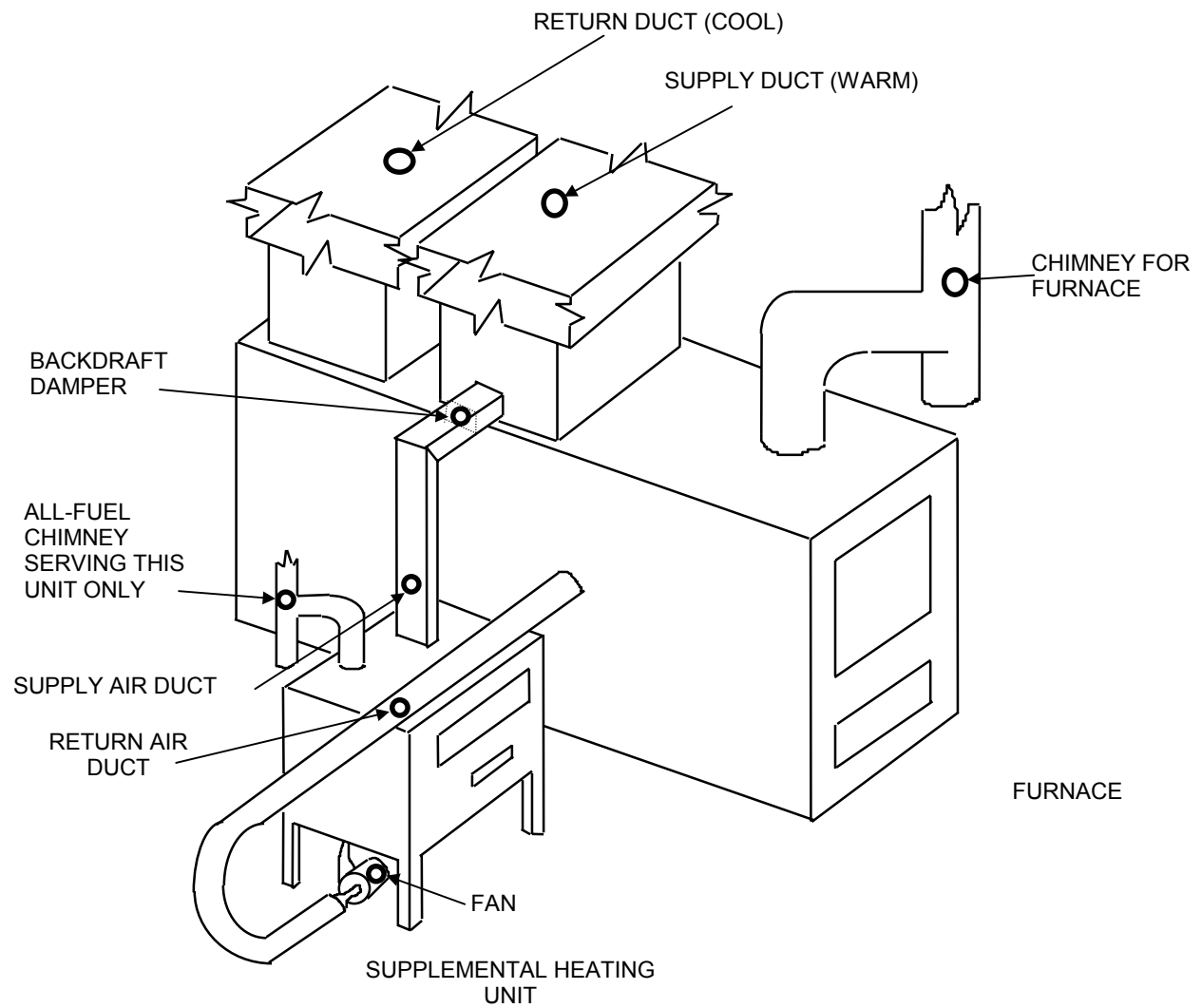


FIGURE 23.045-D

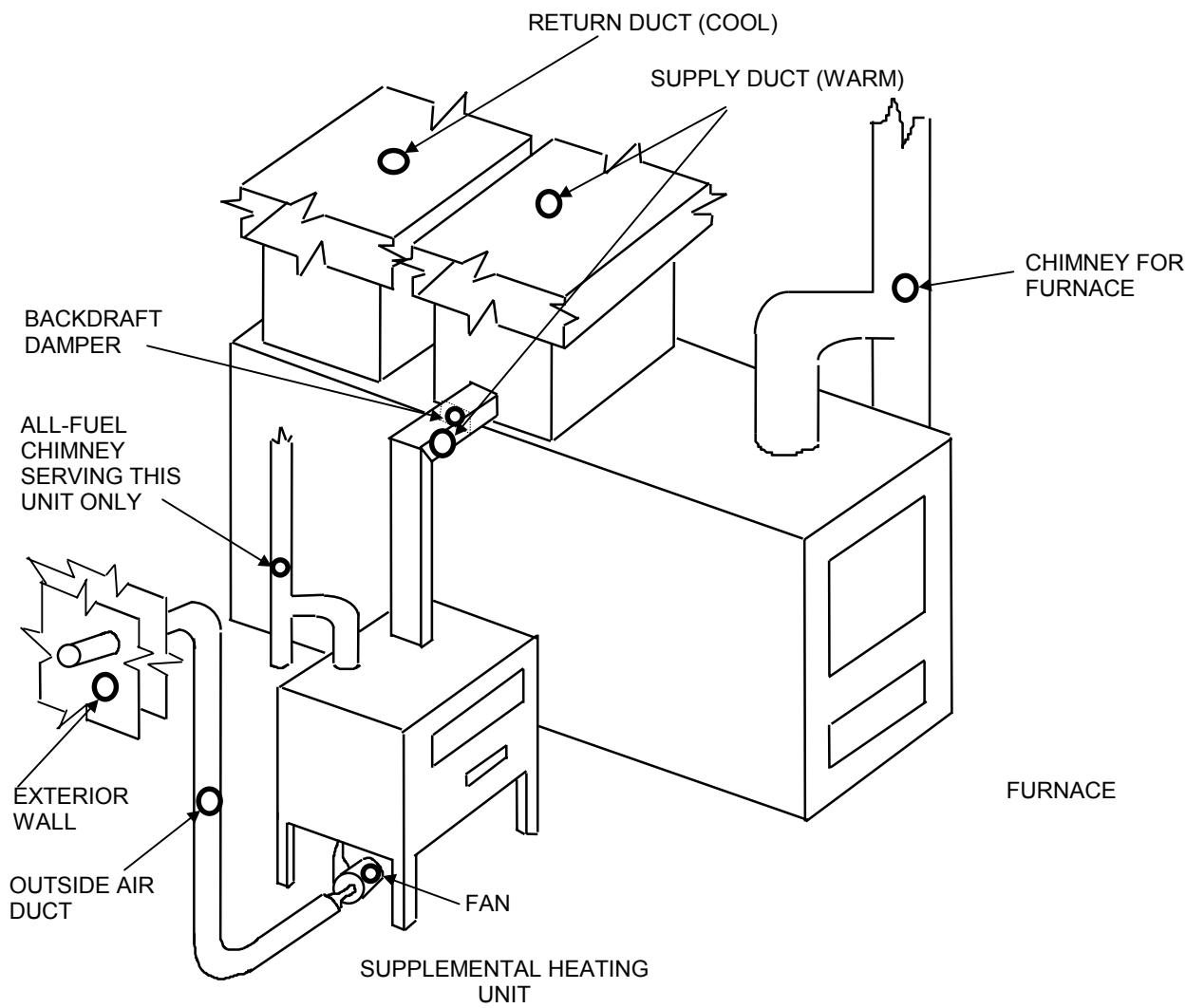
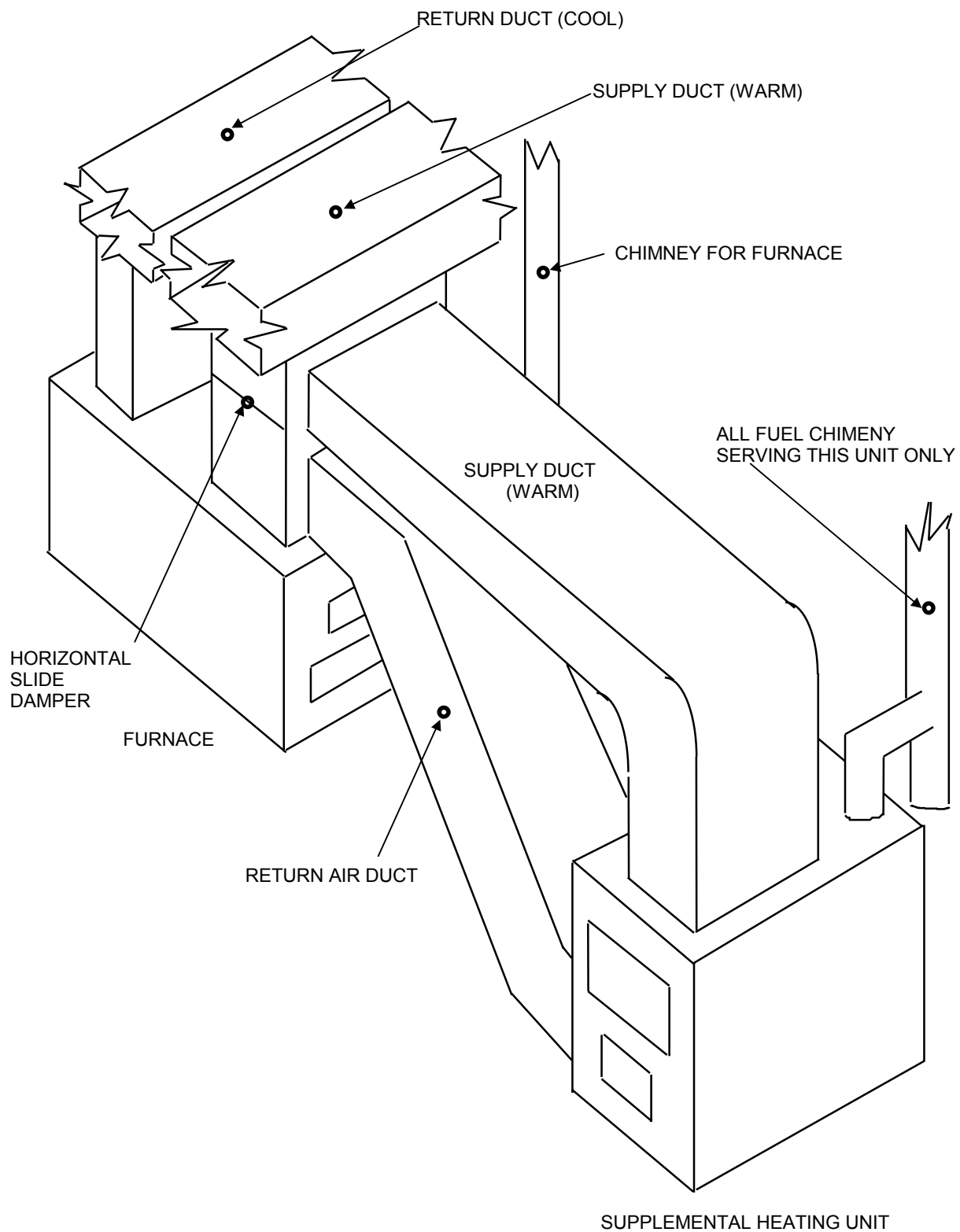


FIGURE 23.045-E



(d) Thermostat. The thermostat control on the supplemental heating unit shall activate the blower motor at a temperature between 100° and 120° F.

(e) Supplemental units. Supplemental solid-fuel-burning units shall be installed to maintain a 3-foot clearance between the unit and the furnace or shall be installed in accordance with the listings of both the supplemental unit and the furnace if such an installation is specifically covered by the listings.

(9) SUPPLY DUCTS. Supply ducts connected to solid-fuel-burning appliances shall have the following minimum clearances to combustibles:

(a) Horizontal ducts. The clearance from combustibles for horizontal ducts shall be as specified in Table 23.045-F.

TABLE 23.045-F

Distance of Ducts From Bonnet or Plenum (inches)	Clearance to Combustibles ¹ Required (inches)
0 to 36	18
over 36 to 72	6
over 72	1

¹ Clearance can be reduced in accordance with Table 23.045-B

(b) Vertical ducts. 1. Air shall travel 6 feet and change directions equivalent to one 90° turn before entering an enclosure of combustible material.

2. Ducts shall have 3/16 inch clearance between the duct and any combustible material.

(10) COMBINATION APPLIANCES. Appliances capable of burning multitypes of fuel shall be listed and installed in accordance with their listing.

Combination Appliances

Note that this section requires combination appliances or dual-fuel appliances to be listed for the combination use. If allowed by the listing, the units may be vented by the same flue.

Table 23.045-C specifies the floor mounts for solid-fuel-burning appliances.

Comm 23.05 Safety controls.

High limit, maximum outlet air temperature and similar safety controls shall be provided on heating equipment.

Comm 23.06 Combustion air.

(1) SCOPE. (a) Naturally vented appliances and other appliances that require air for combustion and dilution of flue gases to be taken from within the building shall comply with this section.

(b) Appliances that are provided with a direct supply of outside air for combustion in accordance with the manufacturer's installation instructions and listing are not required to comply with this section.

(c) Where the appliance listing and manufacturer's instructions are more stringent than the provisions of this section, the listing and manufacturer's instructions apply.

(2) METHODS FOR PROVIDING AIR. Air for combustion and dilution shall be provided in accordance with one of the following:

(a) If the vapor retarder is not continuous on walls and ceilings exposed to the outside atmosphere as allowed by s. Comm 22.22, air may be provided from inside the building in accordance with sub. (3).

(b) Air may be provided from outside the building in accordance with sub. (4).

(c) The appliance may be installed in accordance with its listing and manufacturer's instructions. Where all walls and ceilings exposed to the outside atmosphere are provided with a continuous vapor retarder, any requirements for unusually tight construction shall be met.

(d) An engineered system providing an adequate supply of air for combustion ventilation and dilution of flue gases may be installed if approved by the department.

(3) AIR FROM INSIDE THE BUILDING. (a) 1. The equipment shall be located in a space with a volume not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel-burning appliances drawing combustion and dilution air from that space.

2. The space may be made up of more than one room if the rooms are connected through doorways without doors or connected through sets of openings described in par. (b).

(b) 1. When needed to connect rooms, two opening shall be provided, one within 1 foot of the ceiling of the room and one within 1 foot of the floor.

2. The net free area of openings shall be calculated in accordance with sub. (5).

3. The net free area of each opening shall be a minimum of one square inch per 1000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the communicating rooms, but shall be not less than 100 square inches.

(4) AIR FROM OUTSIDE THE BUILDING. (a) When air for combustion and dilution is provided from outside the building, as allowed under subm. (2) (b), one of the methods specified in pars. (b) to (d) shall be used.

(b) Openings may be provided to connect rooms containing appliances to the outdoors.

1. a. Two openings shall be provided, one within 1 foot of the ceiling of the room and one within 1 foot of the floor.

b. Openings may connect directly to the outdoors or to the outdoors through a horizontal or vertical duct.

c. The net free area of openings shall be calculated in accordance with sub. (5).

2. The net free area of each direct opening to the outdoors not using a duct shall be a minimum of one square inch per 4000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

3. a. The net free area of each opening connected to the outdoors through a horizontal duct shall be a minimum of one square inch per 2000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

b. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

4. a. The net free area of each opening connected to the outdoors through a vertical duct shall be a minimum of one square inch per 4000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

b. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

(c) 1. Where all appliances drawing air for combustion and dilution from the room are gas appliances, air may be provided via a single opening to connect the room to the outdoors in accordance with this paragraph.

2. a. The opening shall be located within 1 foot of the ceiling of the room.

b. The opening may connect directly to the outdoors, may connect to the outdoors through a horizontal duct, or may connect to the outdoors through a vertical duct.

c. The net free area of opening shall be calculated in accordance with sub. (5).

3. a. The net free area of the opening shall be a minimum of one square inch per 3000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room, and not less than the combined cross-sectional flow areas of the appliance flue collars or draft hood outlets.

b. The cross-sectional area of the duct shall be equal to or greater than the required size of the opening.

4. The appliances shall have a minimum clearance to the surfaces of the room of 1 inch at the sides and back of the appliance and 6 inches at the front of the appliance.

(d) 1. A combination of openings to the outside and openings to other rooms may be used in accordance with this paragraph.

2. a. One opening shall connect directly to the outdoors, connect to the outdoors through a horizontal duct, or connect to the outdoors through a vertical duct.

b. The net free area of the opening shall be calculated in accordance with sub. (5).

c. The net free area of the opening shall be a minimum of one square inch per 5000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the room.

d. The cross-sectional area of a duct, if used, shall be equal to or greater than the required size of the opening.

3. a. The equipment shall be located in a space with a volume not less than 50 cubic feet per 1000 Btu/h of the combined input rating of all fuel-burning appliances installed in that space.

b. The space may be made up of more than one room if the rooms are connected through openings without doors or connected through sets of openings described in subd. 3.

4. a. When needed to connect rooms, two openings shall be provided, one within 1 foot of the ceiling of the room and one within 1 foot of the floor.

b. The net free area of openings shall be calculated in accordance with sub. (5).

c. The net free area of each opening shall be a minimum of one square inch per 1000 Btu/h of combined input rating of the fuel-burning appliances drawing combustion and dilution air from the communicating rooms, but shall be not less than 100 square inches.

(5) NET FREE AREA CALCULATION. (a) The required size of openings for combustion and dilution air shall be based on the net free area of each opening.

(b) The net free area of an opening shall be that specified by the manufacturer of the opening covering or by a source approved by the department.

(c) In the absence of such information, openings covered with metal louvers shall be deemed to have a net free area of 75 percent of the area of the opening, and openings covered with wood louvers shall be deemed to have a net free area of 25 percent of the area of the opening.

(6) INTERLOCKING OF DAMPERS. (a) Where the combustion air openings are provided with volume, smoke or fire dampers, the dampers shall be electronically interlocked with the firing cycle of the appliances served, so as to prevent operation of any appliance that draws combustion and dilution air from the room when any of the dampers are closed.

(b) Manually operated dampers shall not be installed in combustion air openings.

(7) SIMULTANEOUS OPERATION. (a) The equipment and appliances within every room containing fuel-burning appliances shall be installed so as to allow the free circulation of air.

(b) Provisions shall be made to allow for the simultaneous operation of mechanical exhaust systems, fireplaces, clothes dryers or other equipment and appliances operating in the same room or space from which combustion air and dilution air is being drawn. The provisions shall prevent the operation of the appliances, equipment and systems from affecting the supply of combustion and dilution air.

Note: Wood typically has a heating value of 8600 BTU per pound.

Combustion Air for Wood Stoves

Question: *Comm 23.045(2)(b). How do I calculate if a wood stove needs outside combustion air because of small room size?*

Answer: *If the appliance is listed, then an hourly input rating is given and the calculation is straightforward. An unlisted appliance's hourly input BTU rating can be figured on the following basis:*

$$\begin{aligned} \frac{\text{BTU input}}{\text{hr.}} &= C \times 60\% (\% \text{ firebox fill}) \times \frac{40 \text{ lbs. wood}}{\text{Cu. ft.}} \times \frac{8600 \text{ BTU}}{\text{lb. wood}} \times \frac{1 \text{ firebox full}}{2 \text{ hrs.}} \\ &= \frac{103,200 \text{ BTU/HR}}{\text{cu. ft.}} \times C \end{aligned}$$

where: $C = \text{firebox capacity (cu. ft.)} = l \times w \times h$
 = product of inside firebox dimensions in feet.

Combustion Air

The code offers several methods to supply adequate combustion air. Below is a highlighted listing of the options. Also see the optional Makeup and Combustion Air Worksheet at the end of this chapter.

Method 1. Inside Air (Discontinuous Vapor Retarder) (23.06(3)): Allows combustion air to be drawn from an inside space if the building has a discontinuous vapor barrier, as is permitted at boxsills or below grade walls by s. 22.22. The space shall provide a room volume of at least 50 cubic feet per 1000 btu/hr combined input rating of all open combustion appliances in that space. An inside space may include several rooms if connected with high and low openings, with each opening providing one square inch of clear opening per 1000 btu/hr input rating, but not less than 100 square inches each.

Method 2. Inside & Outdoor Air (Continuous Vapor Retarder) (23.06(4)(d)): If a building has a continuous vapor barrier, and therefore cannot use the method of 23.06(b) of taking all air from inside, but does have a room volume of at least 50 cubic feet per 1000 btu/hr combined input rating of all open combustion appliances in that space, then it can use a method of supplementing the inside air with outside air. It shall be via a single, direct or ducted, exterior, high opening, sized at one square inch per 5,000 btu/hr combined input rating.

Method 3. Single Outdoor Opening (Gas Appliances Only) (23.06(4)(c)): If serving only gas appliances, then from outdoors via a single, direct or ducted, exterior, high opening sized at one square inch per 3,000 btu/hr combined input rating, but not less than the combined cross sectional areas of the appliance flue collars or draft hood outlets in that space.

Method 4. Prorated Inside Air Credit Plus Outdoor Air (23.06(2)(d)): For method 1, per current national standards (1999 NFPA 54-5.3.3(c)), we will also allow a combination of drawing inside and outside combustion air, unless prohibited by the appliance manufacturer. This is done by taking a pro-rated credit for an inside space that partially meets method 1, and then making up the difference by pro-rating the outside combustion air otherwise required by Method 5 (23.06(4)(c)). Example: If the inside space provides only 25 cubic feet per 1,000 btus, or half of the size required by method 1, then the additional direct or ducted outside combustion air, as calculated by method 5 can be reduced by one half.

Method 5. Two Outdoor Openings (23.06(4)(b)): From outdoors via high and low direct or vertically ducted exterior openings, each sized at one inch per 4,000 btu/hr combined input rating or via horizontally ducted openings, each sized at one inch per 2,000 btu/hr combined input rating.

EXAMPLE:

1. Determine if the space in which the heating appliances are located is large enough to supply combustion air by itself per Method 1 per s. Comm 23.06(3).
 - a. The plans indicate a utility room will be constructed which houses a:
 - (1) Gas-fired furnace (100,000 BTU input).
 - (2) Gas-fired water heater (33,000 BTU input).

b. The utility room size is approximately 12 ft. long by 5.5 ft. wide. This is 66 sq. ft. in area. The rest of the basement is 934 sq ft. in area.

The "Typical Section" drawing shows the room height to be 7 ft. 6 in. plus the depth of the floor joists 9 1/4 in. Therefore, the height then becomes 8.33 ft. The section also indicates that the vapor retarder is omitted on the boxsill, so s. Comm 23.06(3) may be used.

The volume of the room equals 66 sq. ft. times 8.33 ft. or 549 cu. ft.

c. The minimum room volume on the basis of the equation in s. Comm 23.06(3) is:

$$\text{Room Volume} = \frac{100,000 \text{ BTU furnace} + 33,000 \text{ BTU water heater}}{1,000} \times 50 \text{ cu ft} = 6650 \text{ cu ft}$$

Since the 549 cu. ft. is smaller than 6650 cu. ft., the utility room is too small and another method of supplying combustion air must be used.

2. Try Method 1 again, but draw combustion air from the whole basement via openings in the utility room walls.

a. The volume of the room equals 1000 sq. ft. times 8.33 ft. or 8333 cu. ft. which satisfies the calculated required volume of 6650 cu ft above.

b. Two openings are required (high and low), each sized as follows:

$$\text{Opening Area} = \frac{(100,000 \text{ BTU} + 33,000 \text{ BTU})}{1,000} = 133 \text{ sq. in.}$$

c. This also satisfies the requirement for a minimum 100 sq in openings. (Two 1-sq. ft. = 144 sq.in. openings would suffice.)

OR

3. Try Method 3 per s. Comm 23.06(4)(c) Single Outdoor Opening between the utility room and the exterior. Since the appliances are all gas-fired, this method may be used. (We could take a prorated credit per Method 3 of s. Comm 23.06(2)(d) for the utility room, but because of it smallness, we will not bother in this example.)

a. The minimum size of the single opening is determined as follows:

$$\text{Opening Area} = \frac{133,000 \text{ BTU}}{3,000} = 44 \text{ sq. in.}$$

b. An 8" round duct, which provides 50 sq in, would satisfy this. However, you must also check that the combined flue collar areas of the appliances would be met:

The water heater has a 3" diameter collar which is $3.14(1.5^2) = 7\text{sq in. in area.}$

The furnace has a 6" diameter collar which is $3.14(3^2) = 28\text{sq in. in area.}$

The combined area is $7\text{sq in} + 28\text{sq in} = 35\text{sq in} - \text{OK}$

c. Consideration should be given to the blocking effect of screens and louvers in air intake openings. Assuming 1/8" screen, multiply the 50 sq in of the 8" diameter duct by 0.8 to arrive at 40 sq. in., which still satisfies the requirement.

Comm 23.062 Mechanical draft systems.

Where a mechanical draft system, such as a fan is used, provision shall be made to prevent the flow of gas to the main burners when the draft system is not performing so as to satisfy the operating requirements of the system for safe performance.

Comm 23.065 Equipment maintenance information.

Required regular maintenance actions for equipment shall be clearly stated and incorporated on a readily accessible label. The label may be limited to identifying, by title or publication number, the operation and maintenance manual for that particular model and type of equipment. Maintenance instructions shall be furnished for equipment which requires preventive maintenance for efficient operation. Manufacturer's manuals for all installed heating and cooling equipment and service water heating equipment shall be provided.

Subchapter IV — Delivery Systems

Comm 23.07 Air distribution systems.

(1) SIZING. All air distribution systems shall be sized using the velocities and static pressure losses listed in Table 23.07.

TABLE 23.07
DUCT VELOCITIES

Designation	Maximum Static Pressure Loss (in WG/100 feet)	Minimum Velocity (feet/minute)	Maximum Velocity (feet/minute)
Main trunk duct	.10	700-900	800-1200
Branch duct	.10	600	700-1000
Branch riser	.10	500	650-800
Outdoor intake	.10	500	800
Grilles or openings	.10	400	600
Return air door undercuts	.10	200	300
Wall louvers	.10	200	300

WG = Water gauge per 100 feet.

(2) **SYSTEM SIZING.** The distribution system, including the evaporator coil, air filters (installed external to the heating unit), ducts, fittings, grilles and registers, shall be sized so that the total external static pressure shall not exceed the static pressure capacity of the fan at the system rated air flow.

(3) **CHANGES IN DUCT SIZE.** Where duct sizes are changed, the slope angle of the transition duct shall not exceed 45°.

Comm 23.08 Ductwork.

(1) **DUCT USE.** Ducts designed for the transmission of air shall be used for no other purpose.

Ducts Used for Other Purposes

Question: *Can electrical, telephone or cable TV wiring be run through air return or supply ducts? Can supply ducts be run through air return ducts or joist spaces used as returns?*

Answer: *No, with three exceptions per National Electrical Code 300-22:*

- *Teflon-insulated wiring.*
- *Metal enclosed wiring.*
- *Romex wiring run perpendicularly to the length of a joist or stud space used as a return air plenum.*

*The department will also allow water and waste piping run perpendicularly through a duct if no pipe joints or cleanouts are within the duct. All penetrations have to be sealed to maintain duct pressures and prevent air leakage. In addition the size of the penetrating utility through the duct can **NOT** effect the velocity or capacity of the duct to transmit the required air volumn of the duct.*

(2) **INTERIOR DUCTS.** All interior ducts shall be constructed in accordance with the following:

(a) **Supply and return air ducts.** Supply and return air ducts shall comply with this paragraph except that ducts attached to appliances may be constructed of materials specified in the appliance listing.

1. Kitchen exhaust ducts and ducts for air exceeding 250°F shall be constructed of sheet metal or lined with sheet metal or constructed of other noncombustible noncorrugated materials.

2. Ducts connected to furnaces shall be constructed of sheet metal for at least 6 feet from the furnace.

3. Spaces formed by unlined wood joists, studs or wood I-joists with solid webs may be used as return air ducts. Spaces used as return air ducts shall be cut off from all remaining unused portions of the space by tight-fitting stops of sheet metal or of wood joist material. Bridging shall be removed from the joist space.